The Effects of Different Beak Trimming Techniques on Plasma Corticosterone and Performance Criteria in Single Comb White Leghorn Hens[1]

G. S. Davis*,[2] K. E. Anderson,* and D. R. Jones†

*Department of Poultry Science, North Carolina State University, Box 7608, Raleigh, North Carolina 27695-7608; and †USDA-ARS, Russell Research Center Poultry Processing and Meat Quality Research Unit, Athens, Georgia 30605

ABSTRACT DeKalb XL chicks were given a beak trim at 6 d of age (6DP) with a 2.8-mm gauge and a beak trim at 11 wk (11WB) with a block cut approximately 2 mm anterior to the nasal openings. Corticosterone (CS) levels of the 6DP treatment were ($P \leq 0.01$) elevated above nontrimmed CS levels at 2 h posttrim; and BW and feed consumption (FC) of the 6DP were depressed until 8 wk of age. At 11 wk of age, CS of the 11WB treatment was ($P \leq 0.02$) elevated above controls at 1, 2, 8, and 5 wk posttrim. The 11WB treatment resulted in a decrease in FC and a reduction in BW at 12, 14, and 16 wk of age, whereas there were no differences among treatments in livability during the pullet phase. At 72 wk of age, FC of the nontrimmed controls was greater than both beak trimmed treatments, and both beak trimmed treatments had greater hen housed eggs, percentage hen day egg production, and percentage livability. Both beak trimmed treatments resulted in better egg income, feed cost per hen, and net income (NI). The 6DP and 11WB beak trim treatments resulted in an improvement of NI per hen of \$1.48 and \$1.86, respectively. In addition, both beak trimmed treatments exhibited better feather score and Hansen's test (fearfulness). It was concluded that pullets and hens could adapt to the physiological stress of beak trimming and out perform, during a lay phase, controls whose beaks were not trimmed.

(*Key words*: beak trim, corticosterone, production criteria)

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INTRODUCTION

Beak trimming continues to be a method of choice in the United States for controlling cannibalism, feather pecking, and excessive mortality that occurs in table egg pullet production. However, beak trimming of pullets has been under the scrutiny of animal welfare groups that have criticized this practice as being inhumane (Harrison, 1964). To counter the animal welfare concerns, many studies have reported the benefits of beak trimming on pullet production criteria. When properly performed, beak trimming of pullets has been shown to reduce mortality (Carson, 1975; Lee and Reid, 1977; Craig and Lee, 1989; Craig and Lee, 1990), reduce toe pecking (Cunningham, 1992), reduce feed consumption (Lee and Reid, 1977; Lee, 1980; Blokhuis et al., 1987; Lee and Craig, 1990), improve feed efficiency (Lee and Reid, 1977; Lee, 1980), delay sexual maturity (Beane et al., 1967; Carey, 1990), and improve egg production (Morgan, 1957; Bramhall and Little, 1966; Kuo et al., 1991). Beak trimming has also been reported to result in positive behavioral changes in chickens. Several reports have indicated that beak trimming reduced cannibalistic behavior, beak inflicted feather loss, and fearfulness in White Leghorn pullets (Craig and Lee, 1990; Lee and Craig, 1990; Kuo et al., 1991).

Although many reports have examined production and behavioral changes in pullets after beak trimming, only a few studies have examined a hormonal stress response. The adrenal cortical hormone, corticosterone (CS), is a hormone that is often measured and reported as an indicator of acute stress in poultry (Beuving and Vonder, 1978; Davis et al., 2000), whereas increases in heterophil to lymphocyte ratios (H:L) caused by heteropilia have been reported to be an indicator of chronic stress (Siegel, 1995; Davis et al., 2000). Thus, the objectives of this study were to examine plasma CS levels, H:L ratios, production criteria, fearfulness behavior, and feather loss in Single Comb

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[2]To whom correspondence should be addressed: Gary_Davis@ncsu.edu.

Abbreviation Key: CS = corticosterone; EI = egg income; FC = feed consumption; HE = hen housed eggs; %HDP = percentage hen day egg production; H:L = heterophil to lymphocyte ratio; NI = net income; 6DP = 6 d precision beak trim; 11WB = 11 wk beak trim.

TABLE 1. Body weights, cumulative feed consumption, and percent livability as affected by beak-trim treatment from 2 to 16 wk of age

Treatment[1]	BW (g)	FC[2]	Liv	BW	FC	Liv	BW	FC	Liv	BW	FC	Liv
Weeks of age		2			4			6			8	
Non-Trim	133.3^{A}	196.4^{A}	98.1^{A}	308.9^{a}	465.6^{a}	99.1^{a}	483.6^{A}	787.7^{A}	96.7^{A}	689.3^{A}	831.5^{A}	96.1^{A}
6DP	125.4^{B}	181.0^{B}	98.1^{A}	292.2^{b}	443.1^{b}	99.3^{a}	474.2^{B}	697.0^{B}	97.8^{A}	681.3^{A}	824.2^{A}	97.5^{A}
11W^{B}	132.9^{A}	192.6^{A}	99.4^{A}	309.3^{a}	443.6^{b}	99.1^{a}	481.9^{A}	770.4^{A}	97.7^{A}	690.6^{A}	830.0^{A}	97.1^{A}
SEM	0.697	2.71	0.611	2.79	6.81	0.290	2.46	14.89	0.481	4.66	16.64	0.524
		10			12			14			16	
Non-Trim	878.5^{A}	809.3^{A}	95.9^{A}	1,028.5^{A}	827.6^{A}	95.7^{A}	1147.7^{A}	802.6^{A}	95.5^{A}	1,290.4^{A}	819.8^{A}	95.4^{A}
6DP	874.2^{A}	789.6^{A}	97.4^{A}	1,015.8^{A}	810.4^{A}	97.2^{A}	1,136.8^{A}	795.0^{A}	97.1^{A}	1,287.1^{A}	763.5^{B}	97.0^{A}
11W^{B}	871.1^{A}	791.6^{A}	96.6^{A}	791.0^{B}	591.7^{B}	96.2^{A}	1,011.3^{B}	712.1^{B}	95.9^{A}	1,201.0^{B}	731.8^{B}	95.6^{A}
SEM	4.36	20.0	0.556	6.71	24.90	0.562	5.77	16.94	0.582	8.74	14.30	0.593

^{A,B}Means within a column with different superscripts are significantly different ($P \leq 0.0001$).

^{a,b}Means within a column with different superscripts are significantly different (≤ 0.05).

[1]Nontrim = Nonbeak trimmed hens; 6DP = 6 d precision beak trim; 11WB = 11 wk block beak trim.

[2]FC = cumulative feed consumption (g/bird); Liv = percentage livability.

White Leghorn DeKalb XL pullets and hens after 2 different techniques of beak trimming.

MATERIALS AND METHODS

This experiment was conducted in a manner that avoided unnecessary discomfort to the birds by the use of proper management techniques (United States Department of Human Health and Services). In addition, this experiment was conducted under an approved Institutional Animal Care and Use Protocol.

One-day-old Single Comb White Leghorn DeKalb XL chicks were housed in a trideck battery-style cage, which was an environmentally controlled brood/grow house, at a density of 310 cm2/bird. The house contained 192 replicates of 20 chicks each for a total of 3,840. A control and 2 beak-trimmed treatments were allocated 64 replicates each and were randomly selected across all cage rows and levels. During the pullet phase a step-down light-dark cycle, using cool white flourescent lights, was used beginning at 23L:1D at 1 d of age and ending at 15L:9D at 18 wk of age. Temperatures were maintained at 26.7 ± 3°C during the pullet and lay phases.

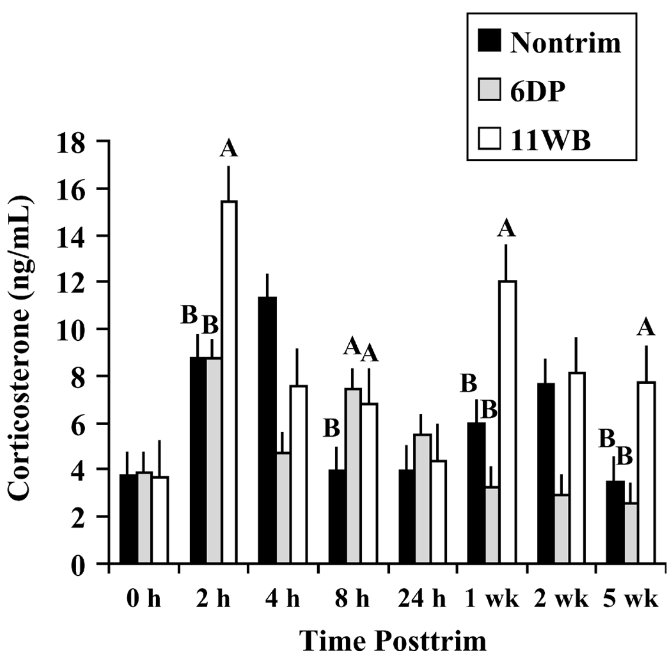

FIGURE 1. *Mean ± SEM corticosterone concentrations in nonbeak trimmed hens (Nontrim), 6 d beak trim, (6DP), and 11 wk block beak trim (11WB) beginning at 11 wk of age. ^{A,B}Means ± SEM at hours posttrim with different letters are significantly different ($P \leq 0.02$).*

Two beak trimming techniques were used: a trim at 6 d (6DP) with a 2.8-mm gauge and a beak trim at 11 wk (11WB) with a block cut approximately 2 mm anterior to the nasal openings. Plasma samples were collected from 10 birds of the nontrimmed controls, the 6DP treatments, and the 11WB treatments at 0, 1, 2, and 4 h posttrim at 6 d of age; pullets from which plasma samples were obtained from the 11WB trim were hand held for 1 min each prior to blood sampling. Essentially, the 11WB treatment was a control group until beak trimming occurred at 11 wk of age. At 11 wk of age, blood samples were obtained from 8 birds of the nontrimmed, 6DP, and 11WB treatments at 0, 2, 4, 8, and 24 h and 1, 2, and 5 wk posttrim. The 0 h, 24 h, 1 wk, 2 wk, and 5 wk posttrim blood sampling times were at 1000 h. Blood samples were collected from wing veins within 45 s after capture of each bird. The blood samples were centrifuged (700 × *g* at 4°C), and the plasma was decanted and frozen at –20°C for later analysis.

During the 16 wk of pullet growth, mortality was monitored daily, and BW and feed consumption (FC; cumulative feed consumption, g/bird) were measured every 2 wk. At 17 wk of age, the hens were transferred to an enclosed, mechanically ventilated layer house, and the hens were housed at 361 and 484 cm^2 per bird with 6 birds per cage in trideck layer cages. There was a total of 144 replications with 72 replications equally divided between the high and low density cages, and the beak trimmed treatments were randomly and equally divided within each density. The hens were exposed to a step-up lighting schedule, using cool white fluorescent lights, to 16.5L:7.5D at 36 wk of age. The birds were fully fed a layer ration from 17 until 78 wk of age when the study was

TABLE 2. Egg production criteria of hens as affected by cage density at 72 wk of age

Treatment	FC[1]	HE	% HDP	DEM	Liv	EI	FCH	NI
361 cm^2	112.8^B	318.9^B	79.20^B	48.4^B	76.6^B	19.91^B	10.64^B	9.27^A
484 cm^2	115.8^A	337.0^A	82.00^A	50.4^A	81.9^A	21.09^A	11.38^A	9.71^A
SEM	0.96	4.44	0.307	0.355	1.073	0.238	0.101	0.224

^{A,B}Means within a column with different superscripts are significantly different ($P \leq 0.0001$).

[1]FC = daily feed consumption (g/bird); HE = hen housed eggs; %HDP = percentage hen-day production; DEM = daily egg mass; Liv = percentage livability; EI = Egg income ($); FCH = feed cost per hen ($); NI = net income ($).

terminated. A phase feeding program was used based on flock performance and feed intake according to the procedures of Anderson (1996).

Mortality was monitored daily during the laying phase. Eggs were collected each day, and the following production parameters were measured every 28 d: FC (cumulative feed consumption; g/bird), hen housed eggs (HE), percentage hen-day egg production (%HDP), daily egg mass, and egg grade and size. Egg grade (A, B, Chex) and size distribution of pee wee, small, medium, large, and extra-large eggs were determined with the egg grading standard, size classifications, and specified weights for market eggs of the USDA (2000). Egg income (EI, $/hen), feed cost ($/hen), and net income (NI, $/hen) were calculated based on a 3-yr regional average egg price.

Plasma CS concentrations were determined by RIA Coat-A-Count kits[3] according to the procedures of Davis et al. (2000). To test RIA accuracy, a stock solution of CS was serially diluted to each standard concentration (range of 0.78 to 50 ng/mL). These dilutions were added (spiked) to 1 mL of filtered chicken plasma samples, and the logit-log plot of percentage bound vs. the spiked CS concentrations was compared with the standard curve. The slopes and standard errors of the standard curve and spiked, filtered plasma curve were similar. Pooled chicken plasma was used to determine CV; the intrassay CV was 4.6%, and the interassay CV was 6.3%.

Behavioral observations and feather loss were measured from 8 cages per density/treatment combination during 2 consecutive d at 78 wk of age to examine fearfulness behavior. The Hansen's test was used to measure fearful behavioral patterns (Hansen, 1976; Jin and Craig, 1988). The level of fearfulness in the Hansen's test ranged from 0 (no response) to 4 (severe response). Feather loss was measured according to the methods of Adams et al. (1978), and the level of feather loss ranged from 1 (severe) to 5 (moderate) to 9 (no loss). Also at 78 wk of age blood samples were obtained from 10 hens from each density/treatment combination (total of 60). Blood smears, leucostat stain kits,[4] and an oil emersion microscope (1,000× magnification) were used to determine H:L.

This study was a 2 × 3 factorial arrangement of treatments, and the data were analyzed with the PROC GLM procedure of the Statistical Analysis System (SAS Institute, 1996). Percentages were subjected to arc-sine transformation prior to analysis. All interactions were analyzed, and there were no significant interactions between the main effects of density and beak trimming treatments.

[3]Diagnostic Products Corp., Los Angeles.

[4]Fisher Scientific, Pittsburgh.

RESULTS AND DISCUSSION

Rearing Phase

Circulating CS concentrations of the nontrimmed and 6DP treatments at 6 d of age were similar at baseline levels, 1 h, and 4 h posttrim (data not shown). However, at 2 h posttrim at 6 d of age, mean CS (± pooled SEM) of the 6DP treatment (27.94 ± 3.2 ng/mL) was significantly greater ($P \leq 0.003$) than CS of nontrimmed controls (9.54 ng/mL), and CS levels among treatments were similar at 4 h posttrim (data not shown). After the 6DP trim, mean BW and FC of the beak trim treatment were significantly ($P \leq 0.02$) lower than those of the nontrimmed treatment until 8 wk of age (Table 1). Apparently, the 6DP beak trim induced a transient CS stress response that corresponded with a temporary reduction in BW and FC between 2 and 6 wk of age. Pullets in the 6DP treatment evidently acclimated to the stressor of beak trimming and underwent compensatory growth in that BW was similar to nontrimmed controls between 8 and 16 wk of age (Table 1). In addition, livability was not affected by the 6DP beak trim during the entire pullet phase. Thus, it was concluded that a 6DP beak trim might result in a transient physiological stress response without adversely affecting bird welfare and performance criteria during the pullet phase.

After the 11WB, plasma CS concentrations of this treatment were ($P \leq 0.02$) elevated above nontrimmed controls at 2 h, 8 h, 1 wk, and 5 wk posttrim (Figure 1). Although livability was not adversely affected, the persistent elevation in CS of the 11WB treatment corresponded to 23 and 29% reductions, compared with those of nontrimmed controls in BW and FC, respectively, at 12 wk of age; 12 and 11% reductions in BW and FC, respectively, at 14 wk of age; and 7 and 11% reductions in BW and FC, respectively, at 16 wk of age (Table 1). Elevated CS concentrations observed from 12 to 17 wk of age could be interpreted as periods of physiological stress, or because CS is a gluconeogenic hormone (i.e., production of glucose from endogenous sources, usually protein), elevated CS might have been correlated to its metabolic effects to provide glucose and energy due to reduced FC of the

TABLE 3. Egg production criteria of hens as affected by beaktrim treatment at 72 wk of age

Treatment[1]	FC[2]	HE	% HDP	Liv	LE	XLE	EI	FCH	NI
Non-Trim	122.1^{A}	316.1^{B}	79.8^{B}	73.7^{B}	28.9^{B}	53.4^{A}	19.79^{B}	11.41^{A}	8.38^{B}
6DP	113.7^{B}	334.8^{A}	81.2^{A}	81.2^{A}	31.1^{AB}	50.5^{B}	20.96^{A}	11.10^{A}	9.86^{A}
11WB	107.0^{C}	333.0^{A}	80.8^{A}	82.8^{A}	32.8^{A}	48.5^{B}	20.75^{A}	10.52^{B}	10.24^{A}
SEM	11.7	4.44	0.376	1.314	0.805	0.975	0.291	0.124	0.275

$^{A–C}$Means in a column with different superscripts are significantly different ($P \le 0.0001$).

[1]Nontrim = nonbeak precision trimmed hens; 6DP = 6 d beak trim; 11WB = 11 wk block beak trim.

[2]FC = daily feed consumption (g/bird); HE = hen housed eggs; %HDP = percentage hen day production; LE = large eggs; XLE = extra large eggs; EI = egg income ($); FCH = feed cost per hen ($); NI = net income ($).

11WB treatment (Davis et al., 2000). Body weights of the 11WB treatment were consistently lower throughout the pullet and entire egg laying period, and at 78 wk the mean BW ± pooled SEM of the 11WB (1,795 ± 17.5 g) and the 6DP (1,848 g) treatments were lower ($P \le 0.04$) than BW of the nontrimmed controls (1,860 g).

Laying Phase

Several production criteria were affected by cage density and the beak trimming procedures during the laying phase. Those criteria at 72 wk of age that were different ($P \le 0.0001$) are shown in Tables 2 and 3. Hens in the lower density cage environment (484 cm^2/ bird) had higher FC, HE, %HDP, daily egg mass, livability, EI, feed cost per hen, and NI. The EI, FC, and NI of hens caged at 484 cm^2/bird were improved by $1.18, $0.74, and $0.44, respectively, compared with values for birds caged at 361 cm2/bird. Hens in the low density cages had better production criteria, and they exhibited improved ($P \le 0.05$) feather score but more ($P \le 0.05$) fearfulness behavior than hens in the high density cages (Table 4). This finding supports the work of Carroll et al. (1993) that birds in low density environments exhibit increased fearfulness.

If productivity is an indicator of welfare status, then the 6DP and 11WB treatments enhanced bird welfare in this strain. The data in Table 3 show that both beak trimmed treatments had greater HE, %HDP, and percentage livability although the nontrimmed controls used more feed. The increased feed use of the nontrimmed hens may be accounted for by the increase in feed wastage observed under those replicates. Hens in the beak trim treatments produced more large eggs and fewer extra-large eggs. However, both beak trimmed treatments resulted in better EI and NI. Hens in the 6DP and 11WB beak trim treatments resulted in an improvement in NI per hen of $1.48 and $1.86, respectively. These data show improvements in production criteria of the beak trimmed hens with less FC, therefore, it is speculated that the stress of beak trimming in the pullet phase influenced better use of feed rations or less feed wastage during the laying phase.

Feather score was higher ($P \le 0.05$) and fearfulness behavior was lower ($P \le 0.05$) in hens in both beak trim treatments compared with those of controls (Table 4). These data suggest that beak trimming may reduce cannibalistic behavior resulting in less fearfulness behavior and feather loss thereby reducing mortality. This observation is confirmed by the improvement of livability of the 6DP (82.2%) and 11WB (82.8%) treatments compared with livability of the nontrimmed controls (73.7%) at 78 wk of age.

It appears that any negative aspects that may occur due to beak trimming in the pullet phase can be offset in the laying phase; and that the long-term welfare of the hen is not compromised but is enhanced by beak trimming. Siegel (1995) reported that H:L is an indicator of chronic stress. At 78 wk of age, no significant differences in H:L were found between the 2 densities or among the controls and beak trim treatments. Thus, it was concluded that hens can acclimate to the physiological stress of beak trimming during the pullet phase and this acclimation process can enhance their performance and subsequent welfare criteria during the laying phase.

TABLE 4. Feather score, Hansen's test, and heterophil to lymphocyte ratio of 78 wk old hens in each density and beak-trim treatment group

Treatment	Feather score[1]	Hansen's test[2]	H:L[3]
Density			
361 cm^2	5.15^{b}	1.75^{b}	0.162^{a}
484 cm^2	5.70^{a}	2.08^{a}	0.135^{a}
SEM	0.12	0.10	0.015
Beak Trim[4]			
Non-Trim	3.55^{c}	2.40^{a}	0.130^{a}
6DP	5.80^{b}	1.84^{b}	0.138^{a}
11WB	6.92^{a}	1.51^{c}	0.176^{a}
SEM	0.11	0.12	0.018

$^{a–c}$Means within a treatment column with different superscripts are significantly different ($P \le 0.05$).

[1]Where 1 = severe, 5 = moderate, and 9 = no feather loss.

[2]Where 0 = no response to 4 = severe response.

[3]H:L = heterophil to lymphocyte ratio.

[4]Nontrim = nonbeak trimmed hens; 6DP = 6 d precision beak trim; 11WB = 11 wk block beak trim.

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